2016

Mercury in Fish

In Alberta Water Bodies 2009–2013

Alberta
Government

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Executive Summary

Mercury enters the environment through various natural processes and human activities. Methylmercury is transformed from inorganic forms of mercury via methylation by micro-organisms in natural waters, and can accumulate in some fish. Humans are exposed to very low levels of mercury directly from the air, water and food. Fish consumers may be exposed to relatively higher levels of methylmercury by eating mercury-containing fish from local rivers and lakes. Methylmercury can accumulate in the human body over time. Because methylmercury is a known neurotoxin, it is necessary to limit human exposure.

From 2009 to 2013, the Departments of Environment and Parks (AEP) and Health (AH) initiated a survey of mercury levels in fish in selected water bodies in Alberta. These water bodies are extensively accessed by the public for recreational activities.

This report deals with (1) concentrations of total mercury levels in various fish species collected from the water bodies in Alberta, (2) estimated exposures, (3) fish consumption limits, (4) fish consumption advisories, and (5) health benefits of fish consumption. The results indicate that:

1. Concentrations of total mercury in fish in the water bodies in Alberta were within the ranges for the same fish species from other water bodies elsewhere in Canada and the United States.
2. The estimated human exposures to mercury were high for the high fish intake group (over 100 grams/day) who consume walleye, northern pike, lake trout, and lake whitefish from some rivers, lakes and reservoirs in Alberta.
3. Restriction of consumption of walleye, northern pike, lake trout, and lake whitefish from some water bodies was indicated by the health risk assessment, especially for women of reproductive age, pregnant women and young children.
4. Fish consumption advisories are voluntary measures to reduce potential health risk to local fish consumers. The balance between risk and benefits of consumption of mercury-containing fish needs to be understood and considered by consumers.

The Science Advisory Committee reviewed this document and made recommendations. The Public Health Management Committee made the final decisions on fish consumption advisories and measures to inform the public accordingly.

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Acknowledgments

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1. Introduction

Mercury (Hg) occurs naturally in the environment. There are three forms of mercury: elemental (metallic) mercury, inorganic mercury salts and organic mercury compounds. Mercury enters the environment through natural processes and human activities. The form of mercury most commonly found in the air is volatile elemental mercury. Methylmercury (MeHg) is often formed from other forms of mercury during natural biological processes such as methylation by micro-organisms in the water and sediment. MeHg can accumulate in some fish. People are exposed to very low levels of mercury in the air, water and food. Some people may be exposed to relatively higher levels of MeHg through eating mercury-containing fish. MeHg accumulates in the human body over time. Because MeHg is a known neurotoxin, it is necessary to limit human exposure.

To protect public health, Health Canada has proposed mercury guidelines, and advisories for different fish consumer groups (Health Canada, 1979; Feeley and Lo, 1998; Health Canada 2007; Feeley 2008) based on total mercury (THg) or MeHg. These values are expressed either in units of µg THg or MeHg per g of fish flesh or as a Provisional Tolerable Daily Intake (pTDI) in units of µg THg or MeHg per kg of consumer body mass per day (see Section 2.1):

1. 0.5 µg THg/g for all commercial fish/seafood (Guideline);
2. 1.0 µg THg/g for certain commercial fish species such as fresh and frozen tuna, shark, swordfish, escolar, marlin and orange roughy which are known to be consumed less frequently (Advisory); and
3. 0.2 µg THg/g for subsistence consumers (Advisory)
4. 0.2 µg MeHg/kg bw/d pTDI for women of reproductive age and young children (Guideline);
5. 0.47 µg MeHg/kg bw/d pTDI for the general population (Guideline)

The guidelines for commercial fish/seafood are used as a general screening criterion, with the knowledge that most species of commercial fish usually contain lower levels (< 0.1 µg/g) of mercury. This guideline is enforceable by the Canadian Food Inspection Agency (CFIA) for commercial fish. For example, the CFIA has been monitoring total mercury (THg) levels in commercial fish caught from Lake Athabasca in Alberta since the early 1990s. The recommendation for subsistence consumers proposed by Health Canada since the 70's is used for First Nations and Inuit people relying on subsistence fresh water fishing when Medical Services Branch became aware of long term fish consumption patterns of over 100 g/d (Health Canada 1979). The First Nations and Inuit subsistence consumers should limit their fish consumption if the mercury levels in fish are over 0.2 µg THg/g. Over 0.5 µg THg/g fish consumption should be avoided for any consumer.

Fish consumption advisories are developed based on these pTDIs. These advisories provide the public with a warning of potential health risk resulting from consuming

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local mercury-containing fish. Fish consumption advisories are designed to minimize the potential health risks to fish consumers who can voluntarily restrict their fish consumption.

From 2009 to 2013, the Departments of Environment and Parks (AEP) and Health (AH) initiated a survey of mercury levels in fish in selected water bodies in Alberta. These water bodies are extensively accessible to the public for recreational activities.

Environment Canada sampled and tested fish from Alberta lakes for mercury during the same time period. The results of these analyses are included in this report.

The results related to mercury in fish are discussed as follows:

1. mercury concentrations in fish,
2. comparison of mercury concentrations in the same fish species in the rivers and lakes in Canada and the U.S.,
3. local fish consumption rates,
4. estimated exposures for women at reproductive age, children and adults,
5. fish consumption advisories, and
6. health benefits of fish consumption.

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2. Materials and Methods

2.1 Units Used for Expressing Mercury Data

A summary of the different units that may be used for expressing relevant mercury data is provided in Table 1. For the purposes of this report, to facilitate comparison of values reported from different sources, all data on mercury concentration in fish will be expressed as µg of mercury per g of fish, i.e. µg/g, which is equivalent to one unit of mercury per million units of fish (ppm). Likewise, human exposure will be expressed as µg of mercury per kg of human body mass, per day, i.e. µg/kg/d. Consumption advisories will be determined from human exposure limits and expressed as g of fish consumed per week, i.e. g/wk.

Table 1 Units Used for Expressing Mercury Data related to Fish

Measure	Preferred Unit	Alternate Unit	Equivalent Units
Hg Concentration	µg of Hg per g of fish, wet weight µg/g	mg of Hg per kg of fish, wet weight mg/kg	1 unit Hg per million units of fish ppm
pTDI for mercury by humans	µg of Mg/kg per kg of human body weight (mass) per day µg Mg/kg bg BW/d		
Recommended fish consumption limits	g / mercury-containing fish that consumed per week g / wk	kg / mercury-containing fish that consumed per week kg / wk	1 kg = 1 lb (0 g)

2.2 Field Collection

Field collection at 15 sampling sites (Figure 1) was conducted by MDP between September 2008 and January 2010. Sampling sites included:

1. Catling Lake
2. Chrysler Lake (Swan Hills area)
3. Cowan Reservoir
4. Crawling Valley Reservoir
5. Edith Lake
6. Hay River at mouth of Chinchaga River
7. Isle Lake
8. McGregor Lake
9. Lake Athabasca
10. Little Bow Reservoir
11. Kehewin Lake
12. Rolling Hills Reservoir

[illegible]

Field collection of twenty sampling sites (Figure 1) was conducted by [illegible] between January, [illegible] and January, [illegible]. Sampling sites included:

1. [illegible] Lake
2. [illegible] Lake
3. [illegible] Lake
4. [illegible] River
5. [illegible] Lake
6. [illegible] Lake
7. Lac [illegible]
8. [illegible] Lake
9. Lac [illegible]
10. [illegible] Lake East Basin
11. [illegible] Lake West Basin
12. [illegible] Lake
13. [illegible] River
14. [illegible] Lake
15. [illegible] Lake
16. [illegible] Lake[1]
17. [illegible] Lake
18. [illegible] Lake
19. [illegible] Lake
20. [illegible] Lake

Field collection of 10 sampling sites (Figure 2) was conducted by [illegible] between January, [illegible] and January, [illegible]. Sampling sites included:

1. [illegible] Lake
2. [illegible] Lake
3. [illegible] Lake
4. [illegible] Lake
5. [illegible] Lake
6. [illegible] Lake
7. [illegible] Lake
8. [illegible] Lake
9. [illegible] River
10. [illegible] Lake
11. [illegible] Lake
12. [illegible] Lake

---

[1] [illegible]

[2] [illegible]

(12) [illegible] calls
(13) [illegible] calls

[illegible] collection at [illegible] sampling sites (Figure 2) was conducted by [illegible] between January [illegible] and January [illegible]. Sampling sites included:

1. [illegible] calls
2. [illegible] calls
3. [illegible] calls
4. [illegible] calls
5. [illegible] calls
6. [illegible] calls
7. [illegible] calls
8. [illegible] calls
9. [illegible] calls
10. [illegible] calls
11. [illegible] calls
12. [illegible] calls
13. [illegible] calls
14. [illegible] calls
15. [illegible] calls
16. [illegible] calls
17. [illegible] calls
18. [illegible] calls
19. [illegible] calls
20. [illegible] calls
21. [illegible] calls

[illegible] species caught in [illegible] analysis included:

1. [illegible] (female) [illegible]
2. [illegible] calls [illegible]
3. [illegible] [illegible]
4. [illegible] [illegible]
5. [illegible] [illegible]
6. [illegible] [illegible]
7. [illegible] [illegible]
8. [illegible] calls [illegible]
9. [illegible] calls

Field [illegible] collected by [illegible] sexing, and [illegible]. Field [illegible] [illegible] [illegible] and [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible]

[illegible]

[illegible]

[illegible]

Figure 1 Sampling Locations for 2009/2010 and 2010/2011

Figure 2 Sampling Locations for 2011/2012 and 2012/2013

Table 2 Sample Size and Mean of Weight and Length, 2009/2010

Lake and Species	Sample Size	Length (cm)	Wet Weight (g)
Calling Lake			
Northern pike	7	67	1,964
Walleye	10	54	1,456
Chrystina Lake			
Brook trout	15	33	340
Cowoki Reservoir			
Northern pike	6	75	3,409
Walleye	4	59	2,563
Crowfing Valley Reservoir			
Northern pike	8	63	1,588
Walleye	11	48	1,057
Edith Lake			
Brook trout	20	31	352
Hay River			
Walleye	4	49	1,277
Isle Lake			
Northern pike	20	53	1,104
Walleye	21	50	1,247
Kehewin Lake			
Northern pike	10	64	1,635
Walleye	10	45	957
Lake Athabasca			
Lake trout	30	70	2,872
Lake whitefish	4	44	969
Northern pike	29	70	2,936
Walleye	30	50	1,453
Little Bow Reservoir			
Northern pike	9	63	1,489
McGregor Lake			
Northern pike	2	82	4,200
Walleye	12	58	1,893
Rolling Hills Reservoir			
Northern pike	6	80	3,700
Walleye	7	61	2,523
Sturgeon Lake			
Lake whitefish	10	49	1,255
Northern pike	10	61	1,573
Walleye	10	46	917
Touchwood Lake			
Lake whitefish	9	57	1,648
Northern pike	10	86	4,317
Walleye	10	63	2,051
Wabamun Lake			
Lake whitefish	13	47	1,017
Northern pike	10	74	3,092
Whitefish Lake			
Lake whitefish	6	67	3,486
Northern pike	7	81	3,816
Walleye	6	58	1,935

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Table 3 Sample Size and Mean of Weight and Length, 2010/2011

Lake and Species	Sample Size	Length (cm)	Wet Weight (g)
Amisk Lake			
Northern pike	11	53	835
Walleye	10	43	665
Bitscho Lake			
Northern pike	10	75	3,226
Walleye	10	46	1,548
Chinchaga River			
Walleye	5	42	718
Dore Lake[a]			
Northern pike	20	69.8	2,808
Walleye	20	46.1	1,051
Isle Lake			
Northern pike	10	75	3,092
Lake whitefish	13	47	1,017
Kinnaird Lake			
Northern pike	11	56	1,380
Walleye	10	48	1,080
Lac Bellevue			
Walleye	12	44	912
Laurier Lake			
Northern pike	4	81	3,128
Len Thompson			
Rainbow trout	10	33	493
Lesser Slave Lake East Basin			
Northern pike	9	69	2,301
Walleye	14	52	1,136
Lesser Slave Lake West Basin			
Northern pike	16	76	2,913
Walleye	15	59	1,155
Long Lake			
Northern pike	6	51	826
Walleye	2	46	953
Meander River			
Northern pike	7	59	1,414
Walleye	3	39	587
North Wabasca Lake			
Northern pike	10	82	4,294
Walleye	10	57	1,746
Pinehurst Lake			
Northern pike	10	55	1,575
Walleye	8	54	1,839
Pitchimi Lake			
Lake trout	15	79	4,671
Richardson Lake			
Northern pike[a]	19	76.0	4,066
Walleyet[a]	20	47.4	1,289
Lake whitefish	20	46	1,172
Skeleton Lake			
Northern pike	7	52	845
Walleye	9	51	1,462
Snipe Lake			
Northern pike	10	75	2,969
Walleye	10	55	1,846

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Lake and Species	Sample Size	Length (cm)	Wet Weight (g)
Winigami Lake			
Northern pike	11	64	1,533
Walleye	10	59	2,069

[a] Data source – Environment Canada

Table 4 Sample Size and Mean of Weight and Length, 2011/2012

Lake and Species	Sample Size	Length (cm)	Wet Weight (g)
Baptiste Lake			
Northern pike	10	67	1,984
Walleye	8	43	738
Beaver Lake			
Lake whitefish	10	52	1,438
Northern pike	11	67	2,210
Walleye	15	51	1,304
Bourque Lake			
Lake whitefish	10	N/A	849
Northern pike	8	N/A	1,502
Walleye	10	N/A	1,701
Calling Lake			
Northern pike	10	64	1,390
Walleye	12	51	1,076
Cross (Steele)Lake			
Northern pike	10	66	1,860
Heart Lake			
Lake whitefish	7	59	2,371
Northern pike	14	73	2,662
Walleye	27	55	1,964
Hutch Lake			
Walleye	10	53	1,993
Kirby Lake			
Lake whitefish	21	55	1,625
Northern pike	20	73	2,784
Loon River			
Walleye	4	55	989
McMillan Lake			
Northern pike	13	70	1,948
Moose Lake			
Northern pike	17	N/A	1,167
Walleye	10	N/A	1,633
Nipisi Lake			
Northern pike	20	74	2,706
Peerless Lake			
Lake trout	9	71	3,824
Walleye	16	55	1,526
Wolf Lake			
Lake whitefish	10	N/A	1,723
Northern pike	10	N/A	1,258
Walleye	10	N/A	973

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Table 5 Sample Size and Mean of Weight and Length, 2012/2013

Lake and Species	Sample Size	Length (cm)	Wet Weight (g)
Baptiste Lake			
Lake whitefish	5	40	908
Northern pike	10	60	1,370
Walleye	33	49	1,061
Eagle Lake			
Northern pike	13	49	777
Walleye	23	48	1,323
Elinor Lake			
Lake whitefish	14	51	1,347
Northern pike	8	73	1,625
Walleye	17	53	1,968
Ethel Lake			
Lake whitefish	12	59	2,360
Northern pike	9	54	740
Walleye	19	48	1,009
Goodfish Lake			
Northern pike	7	63	1,541
Walleye	9	50	1,261
Gregoire Lake			
Lake whitefish	4	53	2,243
Walleye	9	50	1,273
Hilda Lake			
Northern pike	8	56	1,128
Walleye		19	46
Keho Lake			
Lake whitefish	30	45	874
Northern pike	30	63	1,506
Walleye			24
Lac la Nonne			
Lake whitefish	15	52	1,634
Northern pike	8	55	1,028
Walleye	17	41	684
Lac Ste Anne			
Walleye	7	43	798
Lake Isle			
Northern pike	12	49	813
Marie Lake			
Lake whitefish	8	45	794
Northern pike	7	66	1,986
Walleye	12	49	1,133
McLeod Lake			
Rainbow Trout	7	31	339
Moonshine Lake			
Rainbow Trout	24	29	294
Moose Lake			
Cisco	26	40	900
Lake whitefish	5	60	2,582
Northern pike	50	66	1,759
Walleye	48	55	1,625
Yellow Perch	36	22	155

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Lake and Species	Sample Size	Length (cm)	Wet Weight (g)
Pigeon Lake			
Lake whitefish	38	54	1,934
Walleye	31	49	1,115
Pine Lake			
Northern pike	5	58	1,418
Walleye	5	48	1,112
Rock Island Lake			
Northern pike	17	58	1,290
Walleye	19	51	1,509
Sylvan Lake			
Lake whitefish	24	39	597
Walleye	15	37	584
Whitefish Lake			
Lake whitefish	4	47	962
Northern pike	4	66	1,689
Walleye	16	55	1,526
Wizard Lake			
Northern pike	15	50	841

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2.3 Laboratory Analysis

In 2009/2010, laboratory analysis was performed in the Biogeochemical Analytical Laboratory, Department of Biological Sciences at the University of Alberta. In 2010/2011, 2011/2012 and 2012/2013, laboratory analyses were performed by the Alberta Centre for Toxicology at the University of Calgary, Alberta. The analytical method was based on the modified USEPA methods 200.7 and 200.8 (USEPA 2001). The Environment Canada laboratory used the USEPA method 7473 (USEPA 2007) (Appendix A).

2.4 Estimation of Exposure Ratio

Estimated daily intake (EDI), µg/d, was calculated as follows:

EDI = C * IR *BF/BW

C is a representative measure of THg concentrations in fish muscle (µg/g). From a human health perspective, the amount of MeHg is of most interest. In mercury analyses of fish, the THg in the sample is measured, which is the sum of all forms of mercury present, rather than MeHg because the analysis of MeHg is more expensive. Some studies reported that the percentage of MeHg in THg in fish ranged from 81% to 95% (CFIA 2003). For the purposes of health risk assessments, 100% of THg is assumed to be MeHg, thereby erring on the side of caution.

IR is the human rate of fish consumption (g/d).

BF is bioavailability factor (assumed to be 100%, unitless, the maximum possible and most cautious assumption for this factor).

BW is average body weight in humans (kg). The average of body weight for male and female adults in Alberta is 73 kg. The average human body weights used by Health Canada are 65 kg for women of reproductive age, 26.4 kg for the five to 11 year old group, and 14.4 kg for the one to four year old group (Health Canada 2007).

Exposure ratio (ER, unitless) was calculated by using the following equation:

ER= EDI / pTDI

The provisional tolerable daily intake (pTDI, µg MeHg/kg bw/d) is determined by toxicological risk assessment on mercury (Health Canada 2007). The pTDI for MeHg is the maximum amount of mercury that can be ingested on a daily basis over a lifetime without increased risk of adverse health effects. Health Canada proposed a pTDI of mercury as 0.2 µg Hg/kg bw/d for women of reproductive (childbearing) age and for children. Children refer to two age groups: the five to 11 year old group and the one to four year old group. Health Canada proposed a pTDI of MeHg as 0.47 µg

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Hg/kg bwkl for adults (adult men and adult women who are not of reproductive age).

2.5 Consumption Limits

For quantitative fish advisories, the lifetime average consumption limits (weekly basis) are calculated. The calculation of the consumption limits (CR, g fish per week) is based on the following equation:

CR = pTDI * BW (7 dwk) / C

Where pTDI is provisional tolerable daily intake (µg MeHg/kg bwkl),
BW is body weight (mass) in humans (kg), and
C (µg Hg / g fish) is the measured THg concentration in fish muscle.

The consumption limits that correspond to the Health Canada pTDI and the commercial fish Hg recommendation (maximum concentration of 0.5 µg Hg /g fish) are provided below as a reference point.

Consumption Limits for adult men and adult women not of reproductive age
CR = (0.47µg MeHg/kg bwkl)(73 kg)(7 dwk) / (0.5 µg Hg / g fish) = 480 g fish /week

Consumption Limits for women of reproductive age
CR = (0.2µg MeHg/kg bwkl)(65 kg)(7 dwk) / (0.5 µg Hg / g fish) = 180 g fish /week

Consumption Limits for children age 5 – 11 (bodly weight 26.4 kg)
CR = (0.2µg MeHg/kg bwkl)(26.4 kg)(7 dwk) / (0.5 µg Hg / g fish) = 74 g fish /week

Consumption Limits for children age 1 – 4 (bodly weight 14.4 kg)
CR = (0.2µg MeHg/kg bwkl)(14.4 kg)(7 dwk) / (0.5 µg Hg / g fish) = 40 g fish /week

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3. Results and Discussions

3.1 Concentrations in Fish

The total mercury concentrations in wet weight in fish are summarized in Tables 6, 7, 8, and 9 and Figures 3, 4, 5, and 6. THg concentrations exceeding the 0.5 ug/g commercial fish limit are shown in **bold**.

The average THg concentrations exceeded 0.5 ug/g (ppm) in northern pike in the following water bodies:

1. Amisk Lake
2. Cowski Reservoir
3. Elinor Lake
4. Hilda Lake
5. McGregor Lake
6. Pinehurst Lake
7. Rolling Hills Reservoir
8. Touchwood Lake
9. Whitefish Lake

The average THg concentrations exceeded 0.5 ug/g (ppm) in walleye in the following water bodies:

1. Amisk Lake
2. Baptiste Lake
3. Cowski Reservoir
4. Crowfing Valley reservoir
5. Dore Lake
6. Elinor Lake
7. Hay River at mouth of Chinchaga River
8. Hilda Lake
9. Kinnaird Lake
10. Lac la Nonne
11. McGregor Lake
12. Pinehurst Lake
13. Rolling Hills Reservoir
14. Touchwood Lake and
15. Whitefish Lake
16. Wolf Lake

The average THg concentrations exceeded 0.5 ug/g (ppm) in lake whitefish from Whitefish Lake and in lake trout in Pitchfork Lake.

Table 6 Total Mercury Levels in Fish, [illegible] (µg/g, wet weight)

Lake and Species	Mean	Min	Max
Cutting Lake			
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Crowding Lake			
Brook trout	[illegible]	[illegible]	[illegible]
Cowpit Reservoir			
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Crowding Jacky Reservoir			
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Cuff Lake			
Brook trout	[illegible]	[illegible]	[illegible]
Ice Pond			
Walleye	[illegible]	[illegible]	[illegible]
Ice Lake			
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Kelly Lake			
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Lake Whatcom			
Lake trout	[illegible]	[illegible]	[illegible]
Lake whitefish	[illegible]	[illegible]	[illegible]
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Little Bear Reservoir			
Northern pike	[illegible]	[illegible]	[illegible]
Mattrapa Lake			
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Rocky Hill Reservoir			
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Sherman Lake			
Lake whitefish	[illegible]	[illegible]	[illegible]
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Southwest Lake			
Lake whitefish	[illegible]	[illegible]	[illegible]
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]
Sherman Lake			
Lake whitefish	[illegible]	[illegible]	[illegible]
Northern pike	[illegible]	[illegible]	[illegible]
Whitefish Lake			
Lake whitefish	[illegible]	[illegible]	[illegible]
Northern pike	[illegible]	[illegible]	[illegible]
Walleye	[illegible]	[illegible]	[illegible]

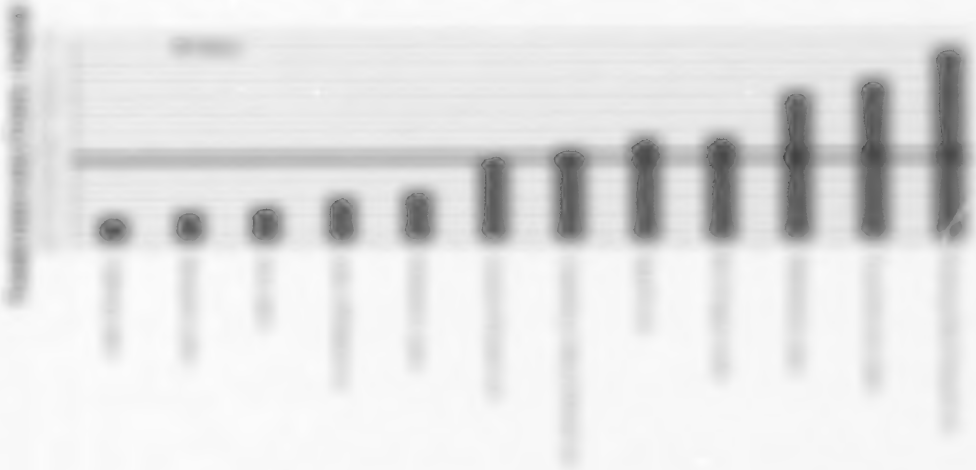

Figure 1 Mean Concentrations of Total Mercury in Fish, [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
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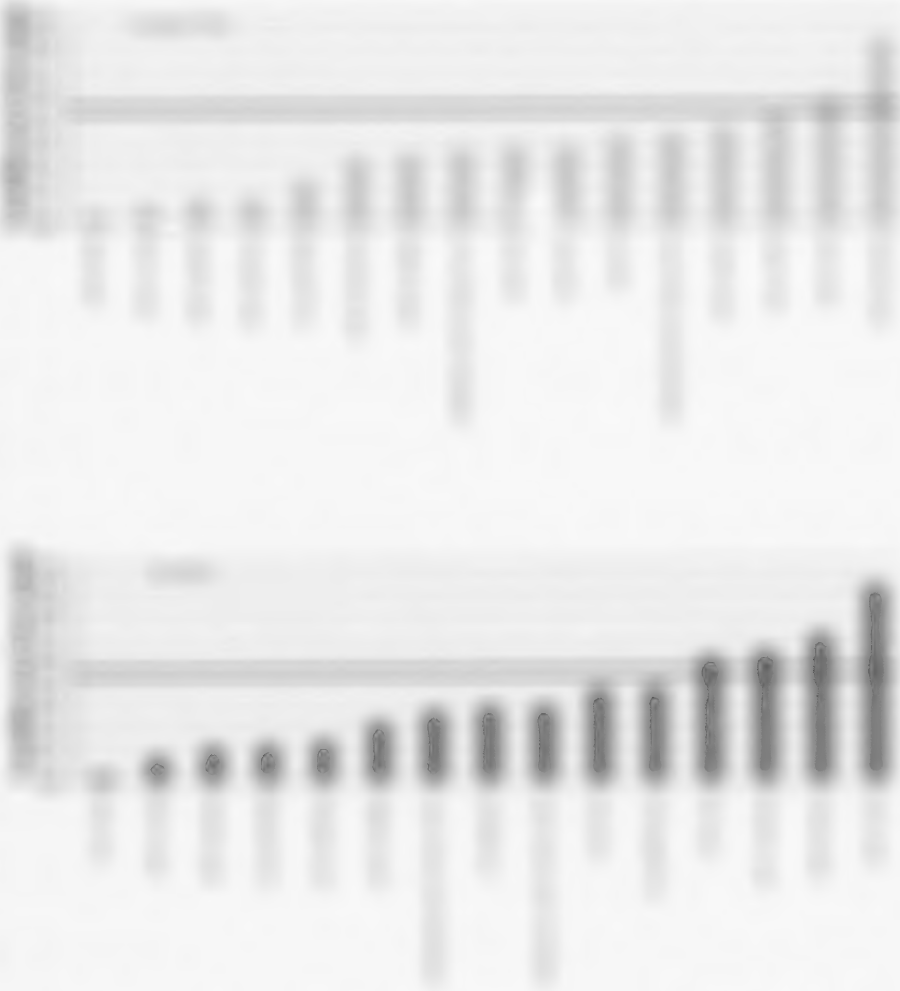

Table 8 Total Mercury Levels in Fish, 2011/2012 (µg/g, wet weight)

Lake and Species	Mean	Min	Max
Baptist Lake			
Northern pike	0.38	0.16	0.72
Walleye	0.21	0.11	0.33
Beaver Lake			
Lake whitefish	0.10	0.08	0.13
Northern pike	0.43	0.21	1.11
Walleye	0.33	0.13	0.69
Bourque Lake			
Lake whitefish	0.07	0.02	0.19
Northern pike	0.30	0.12	0.31
Walleye	0.38	0.28	0.56
Cutting Lake			
Northern pike	0.19	0.08	0.49
Walleye	0.13	0.08	0.32
Cross (Strain) Lake			
Northern pike	0.21	0.07	0.30
Heart Lake			
Lake whitefish	0.02	0.01	0.06
Northern pike	0.18	0.08	0.23
Walleye	0.11	0.06	0.32
Hatch Lake			
Walleye	0.11	0.09	0.13
Kirby Lake			
Lake whitefish	0.02	0.01	0.05
Northern pike	0.13	0.02	0.36
Loon River			
Walleye	0.36	0.19	0.60
McWilliar Lake			
Northern pike	0.39	0.21	0.60
Moonshine Lake			
Rainbow Trout	0.07	0.06	0.12
Moose Lake			
Northern pike	0.33	0.09	0.96
Walleye	0.49	0.29	0.87
Nipis Lake			
Northern pike	0.11	0.05	0.19
Pearlesse Lake			
Lake trout	0.13	0.05	0.31
Wolf Lake			
Lake whitefish	0.10	0.05	0.26
Northern pike	0.36	0.12	0.50
Walleye	0.49	0.25	0.73

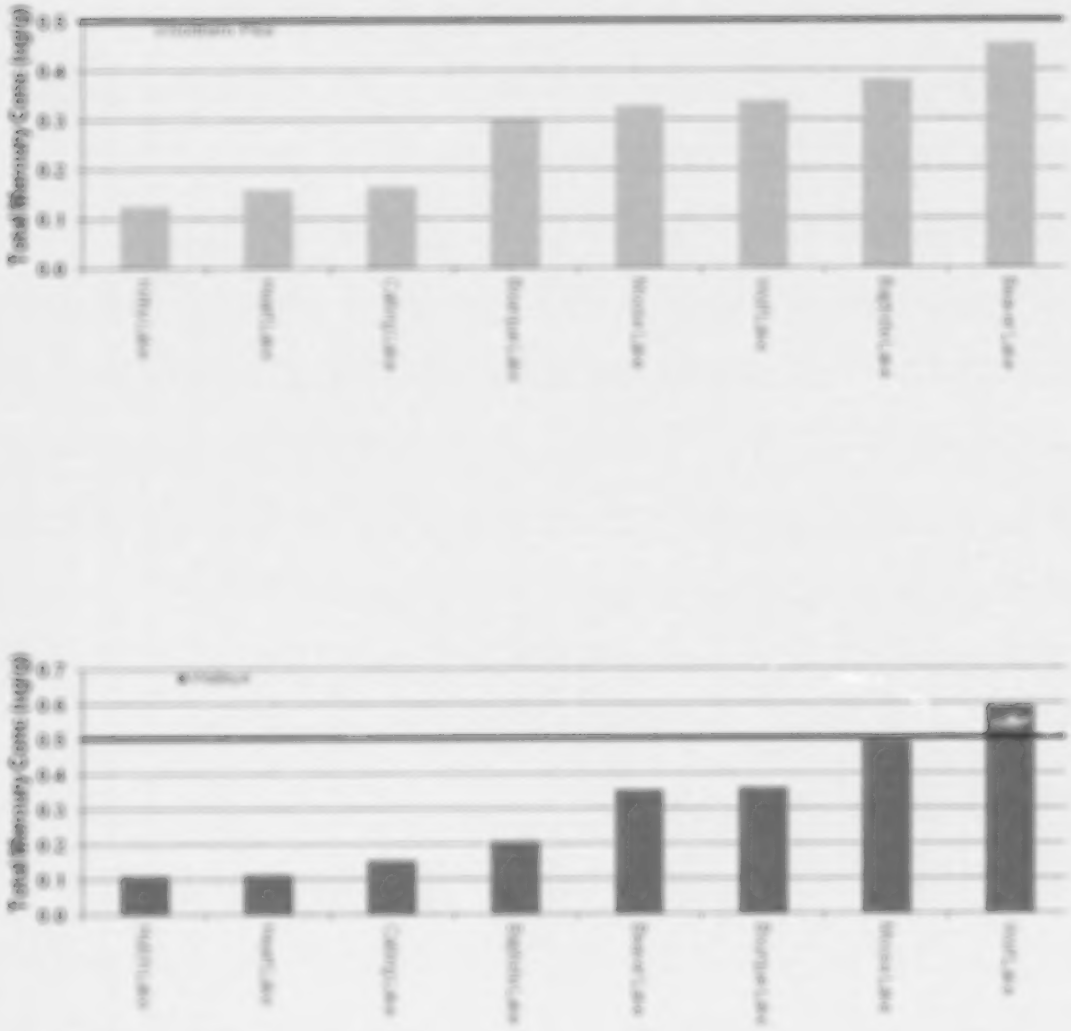

Figure 5 Mean Concentrations of Total Mercury in Fish, 2011/2012

Table 9 Total Mercury Levels in Fish, 2012/2013 (µg/g, wet weight)

Lake and Species	Mean	Min	Max
Baptiste Lake			
Lake whitefish	0.19	0.12	0.23
Northern pike	0.35	0.23	0.64
Walleye	**0.52**	0.25	0.96
Eagle Lake			
Northern pike	0.07	0.05	0.09
Walleye	0.21	0.07	0.51
Elinor Lake			
Lake whitefish	0.11	0.02	0.27
Northern pike	**0.70**	0.32	1.89
Walleye	**0.73**	0.23	1.59
Ethel Lake			
Lake whitefish	0.04	0.02	0.08
Northern pike	0.42	0.10	0.61
Walleye	0.45	0.24	0.89
Goodfish Lake			
Northern pike	0.46	0.27	0.58
Walleye	0.28	0.17	0.45
Gregoire Lake			
Lake whitefish	0.05	0.03	0.06
Walleye	0.19	0.13	0.27
Hilda Lake			
Northern pike	**0.50**	0.31	0.79
Walleye	**0.67**	0.34	0.98
Kehio Lake			
Lake whitefish	0.11	0.04	0.39
Northern pike	0.14	0.09	0.26
Walleye	0.22	0.14	0.59
Lac la Nonne			
Lake whitefish	0.07	0.03	0.23
Northern pike	0.31	0.19	0.43
Walleye	**0.55**	0.20	1.17
Yellow perch	0.08	0.07	0.09
Lac Ste Anne			
Walleye	0.14	0.04	0.24
Lake Isle			
Northern pike	0.07	0.06	0.09
Marie Lake			
Lake whitefish	0.04	0.02	0.16
Northern pike	0.24	0.08	0.41
Walleye	0.19	0.10	0.37
McLeod Lake			
Rainbow Trout	0.05	0.03	0.07
Moonshine Lake			
Rainbow Trout	0.07	0.04	0.12
Moose Lake			
Cisco	0.09	0.04	0.16
Lake whitefish	0.06	0.03	0.11
Northern pike	0.38	0.11	1.32
Walleye	0.49	0.18	0.77
Yellow perch	0.05	0.00	0.12

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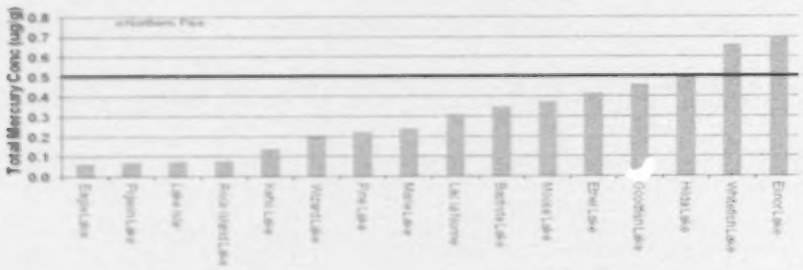
Lake and Species	Mean	Min	Max
Pigeon Lake			
Lake whitefish	0.04	0.02	0.06
Walleye	0.14	0.05	0.28
Pine Lake			
Northern pike	0.22	0.14	0.34
Walleye	0.27	0.12	0.66
Rock Island Lake			
Northern pike	0.08	0.03	0.33
Walleye	0.11	0.04	0.30
Sylvan Lake			
Lake whitefish	0.12	0.03	0.22
Walleye	0.21	0.10	0.64
Whitefish Lake			
Lake whitefish	0.12	0.01	0.32
Northern pike	**0.66**	0.46	0.83
Walleye	**0.78**	0.41	1.30
Wizard Lake			
Northern pike	0.20	0.10	0.35



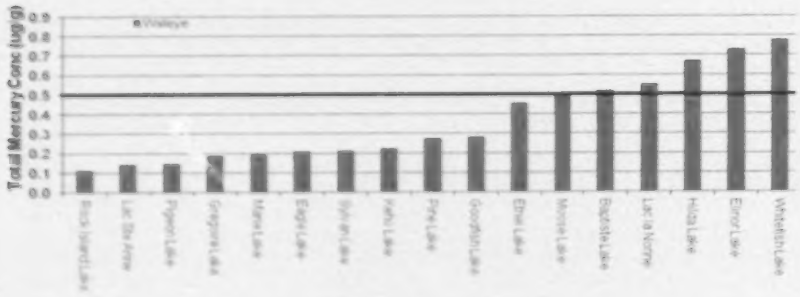


Figure 6 Mean Concentrations of Total Mercury in Fish, 2012/2013

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Mean THg concentrations in walleye, northern pike and lake whitefish collected in previous studies from other water bodies of Alberta are listed in Table 10 (AHW 2009a, b, c, d). There have been recent concerns raised about mercury releases from oil sands development leading to increasing mercury levels in fish in the Athabasca River ecosystem. Evans and Talbot (2012) performed an extensive analysis of data for mercury in walleye, northern pike and lake whitefish. For the Athabasca River (1984-2003) they found decreasing trends for mercury in walleye and lake whitefish. For western Lake Athabasca and its delta, they found a decreasing trend for northern pike (1981-2009) and no trend for walleye (1981-2005). A recent study on mercury deposition in the Athabasca region has shown that there is an increase in mercury concentrations near oil sands operations (Kirk et al. 2014). The increased concentration could impact aquatic ecosystems.

Mean THg concentrations determined by Environment Canada for Lake Athabasca from 2010 to 2013 were consistent with the results obtained by Departments of Environment and Sustainable Resource Development and Health (Appendix A).

Mean THg concentrations in walleye collected in Rolling Hills Reservoir and Touchwood Lake in 2009/2010, in Amisk Lake, Kinnaird Lake, and Pinehurst Lake in 2010/2011, and in Elinor Lake, Hilda Lake, and Whitefish Lake in 2012/2013 were higher than those collected in other water bodies of Alberta previously.

Mean THg concentrations in northern pike collected in McGregor Lake, Rolling Hills Reservoir, Touchwood Lake and Whitefish Lake in 2009/2010, in Amisk Lake and Pinehurst Lake in 2010/2011 and in Elinor Lake and Whitefish Lake in 2012/2013 were higher than those collected in other water bodies of Alberta previously.

Mean THg concentrations in lake whitefish collected in Whitefish Lake in 2009/2010 were higher than those collected in other water bodies of Alberta previously.

The average THg concentrations in Canadian market fish reported by Health Canada ranged from 0.02 to 1.82 μg/g (Health Canada 2007). Compared to Canadian market fish for different fish species, mean THg concentrations in local fish were within the range of Canadian market fish.

Mean THg levels for walleye and northern pike from other water bodies in Canada and the U.S. reported in the literature are summarized in Table 11. Mean THg concentrations for the same fish species collected in the water bodies of Alberta in 2009/2013 were well within the ranges for the same fish species reported in the literature for other North American freshwater fish.

Mean THg concentration in fish fillets varied in other lakes, rivers and reservoirs in Canada and the U.S. The highest mean mercury levels in walleye and Northern pike in the water bodies in eastern and northern Canada ranged from 3.73 to 6.44 μg/g, respectively. High levels tended to be found in larger, older fish. Fish absorb MeHg directly through their gills or through the consumption of prey which contain mercury.

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MeHg is tightly bound to proteins in all fish tissue so larger, older fish contain higher mercury (Munn and Short 1997, Neumann and Ward 1999).

Trophic level is a major factor in mercury accumulation in predatory (fish-eating) fish through biomagnification (Cabana et al. 1994). Bottom-feeding species may accumulate high mercury concentrations from direct contact with contaminated sediment or by eating benthic invertebrates and epibenthic organisms. Predatory fish species may accumulate and biomagnify mercury concentrations via several trophic levels of the food web (Suedel et al. 1994). Predators are commonly used as good indicators of mercury contamination. In this survey, the higher mercury levels were observed in walleye and northern pike which are highly piscivorous predatory fish.

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Table 10 Mean THg Concentrations in Fish Muscles in Alberta Water Bodies

	Mean (µg/g, ww)	Location	Reference
Walleye	0.28 – 0.47	Athabasca River	AHW 2009a, 2009b, 2009c, 2009d
	0.42	Christina Lake	
	0.30	Clearwater River	
	0.13 – 0.16	Gregoire Lake	
	0.27	Keho Lake	
	0.43	Milk River Ridge Reservoir	
	0.63	Lac la Nonne	
	0.13	Lac Ste. Anne	
	0.41	Lake Newell	
	0.11	Pigeon Lake	
	0.52 – 0.79	Pine Coulee Reservoir	
	0.41	Pine Lake	
	0.79	Red Deer River	
	0.68	South Saskatchewan River	
	0.13	Winefred Lake	
Northern pike	0.42	Christina Lake	AHW 2009a, 2009b, 2009c, 2009d
	0.15 – 0.30	Clearwater River	
	0.15 -0.21	Gregoire Lake	
	0.22	Keho Lake	
	0.56	Lac la Nonne	
	0.14	Lac Ste. Anne	
	0.23	Lake Newell	
	0.27 – 0.59	Little Bow River downstream	
	0.04 – 0.29	Little Bow River downstream	
	0.21	Milk River Ridge Reservoir	
	0.11 - 0.22	Muskeg River	
	0.18	Oldman River	
	0.13	Pine Coulee Reservoir	
	0.27	Pine lake	
	0.27	Red Deer River	
	0.35	South Saskatchewan River	
	0.44 – 0.56	Twin Valley Reservoir	
	0.27 – 0.49	Willow Creek Downstream	
	0.08 – 0.13	Winefred Lake	
Lake whitefish	0.09 – 0.17	Athabasca River	AHW 2009a, 2009b, 2009c, 2009d
	0.09	Christina Lake	
	0.04	Gregoire Lake	
	0.10	Keho Lake	
	0.13	Lake Newell	
	0.14	Milk River Ridge Reservoir	
	0.02	Pigeon Lake	
	0.13	South Saskatchewan River	
	0.08	Winefred Lake	

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Table 11 Mean THg Levels in Fish Muscles Reported in the Literature

Species	Mean (µg/g, ww)	Location	Reference
Walleye	0.5	Northwest Ontario lakes (used as a reference for Wabigoon system)	Neff et al. 2012
	0.15 – 0.45	Lake Ontario (seasonal differences)	Zhang et al. 2012
	0.078 – 2.3 dry weight	Boreal lakes within 107 km of Sudbury	Yang et al. 2010
	0.15 to 0.6	Great Lakes with Lake Erie lowest to Lake Superior highest	Bhavsar et al. 2010
	0.05 – 0.99	18 Lakes, Northern Glaciated Plains, US	Selch et al. 2007
	0.19 – 0.30	Reservoirs, Manitoba, Canada	Bodaly et al. 2007
	0.42 – 2.96	Wabigoon River system, Ontario	Kinghorn et al. 2007
	0.98 – 1.00	19 undisturbed lakes, Haute Mauricie, Quebec, Canada	Garcia and Carignan, 2005
	1.29 – 3.73	18 disturbed lakes, Haute Mauricie, Quebec, Canada	Garcia and Carignan, 2005
	0.759	Water bodies in northeastern of US and Canada (N=19,178)	Kamman et al. 2005
	0.58	Great Lakes, US	Gerstenberger and Dellinger, 2002
	0.47	Lakes in Northern Canada	Lockhart et al. 2005
	0.05 – 1.34	Canadian Arctic, Canada	Braune et al. 1999
	0.32 – 1.28	29 Lakes in the La Grande complex watershed, Quebec, Canada	Verdon et al. 1991
	0.19 – 1.43	Mackenzie River Basin Lakes	Evans et al. 2005 a
Northern pike	0.4	Northwest Ontario lakes (used as a reference for Wabigoon system)	Neff et al. 2012
	0.2 – 0.35	Lake Ontario (seasonal differences)	Zhang et al. 2012
	0.5	Twin Valley Reservoir , southern Alberta: 2 year old	Brinkmann & Rasmussen 2010
	1.22	Twin Valley Reservoir , southern Alberta: 5 - 6 year old	Brinkmann & Rasmussen 2010
	0.2 – 0.23	Great Lakes, Lake Huron lowest to Lake Superior highest	Bhavsar et al. 2010
	0.26 – 0.32	Reservoirs, Manitoba, Canada	Bodaly et al. 2007
	0.44 – 2.14	Wabigoon River system, Ontario, Canada	Kinghorn et al. 2007
	1.00 – 2.55	19 undisturbed lakes, Haute Mauricie, Quebec, Canada	Garcia and Carignan, 2005
	1.90 – 6.44	18 disturbed lakes, Haute Mauricie, Quebec, Canada	Garcia and Carignan, 2005
	0.645	lakes, rivers and reservoirs in northeastern of US and Canada (N=19,178)	Kamman et al. 2005
	0.16 – 1.1	Mackenzie River Basin, Canada	Evans, et al. 2005a
	0.12 – 0.74	Mackenzie River Basin, Canada	Evans, et al. 2005b
	0.378	Lakes in Northern Canada	Lockhart et al. 2005
	0.623 – 1.51	Yukon River, Kuskokwim River, US	Jewett et al. 2003
	0.11 – 0.63	Canadian Arctic, Canada	Braune et al. 1999
	0.25 – 0.90	29 Lakes in the La Grande complex watershed, Quebec, Canada	Verdon et al. 1991

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Lake whitefish	<0.1	Northwest Ontario lakes (used as a reference for Wabigoon system)	Neff et al. 2012
	0.35 – 0.37	Reservoirs, Manitoba, Canada	Rodaly et al. 2007
	0.38 – 0.31	Wabigoon River system, Ontario	Kinghorn et al. 2007
	0.54 – 1.18	19 undisturbed lakes, Haute Mauricie, Quebec, Canada	Garcia and Carignan, 2005
	0.51 – 1.19	18 disturbed lakes, Haute Mauricie, Quebec, Canada	Garcia and Carignan, 2005
	0.209	Water bodies in northeastern of US and Canada (N=19,179)	Kamman et al. 2005
	0.91	Great Lakes, US	Gerstenberger and Drellinger, 2002
	0.04 – 0.35	Mackenzie River Basin, Canada	Evans, et al. 2005
	0.11 – 0.13	Lakes in Northern Canada	Lockhart et al. 2005
	0.02 – 0.82	Canadian Arctic, Canada	Braune et al. 1999
	0.07 – 0.30	29 Lakes in the La Grande complex watershed, Quebec, Canada	Verdon et al. 1991

3.2 Local Fish Consumption Rates

Three surveys of fish consumption patterns were conducted in communities of Central Alberta between 1997 and 2000. The first survey was conducted by Alberta Health and Wellness in Swan Hills communities in 1997 (AHW 1997). The second survey was conducted by the First Nations and Inuit Health Branch (FNIHB) of Health Canada for the First Nations people living in the Lesser Slave Lake area in 1999 (Health Canada 1999). The third survey was conducted by the Environmental Health Sciences Program at the University of Alberta for the residents living in the communities near the Athabasca River and tributaries at Hinton (EHSUA 2000).

Table 12 Local Fish Consumption Rates in Communities of Central Alberta

Intake Group	Subsistence Consumer Lesser Slave Lake* mean (g/d)	% ** (n=125)	Local Fish Consumer Swan Hills mean (g/d)	% (n=127)	Local Fish Consumer Athabasca River mean (g/d)	% (n=45)
High (>100g/d)	273	5	167	2	121	2
Medium (30-99 g/d)	46	14	47	13	51	5
Low (5-29 g/d)	13	38	13	28	15	29
Very Low (< 4g/d)	1.6	43	2	57	1.8	66

* mean from Phase I and Phase II studies (Health Canada 1999). ** % of surveyed population

Fish consumption rates in different intake groups from these surveys are summarized in Table 12. A small proportion of local anglers and First Nations people consumed local fish over 100 g/d. Five per cent of the First Nations people in the Lesser Slave Lake communities were high consumers who ate local fish at an average of 273 g/d, much higher than the 2% of those in Swan Hills communities who were high consumers at an average of 167 g/d and those in the communities nearby Hinton who were high consumers at an average rate of 121 g/d. The local fish consumption rates in the survey of the Lesser Slave Lake were similar with the results of the Swan Hills survey in medium, low and very low intake groups. The majority of local fish consumers (85%-92%) consumed fish at a low rate of 1.3 – 10 g/d. The majority of the First Nations group (51%) consumed fish at a low rate of 1.6 – 13 g/d.

The most common fish species consumed by the surveyed populations were rainbow trout, northern pike, walleye, lake whitefish, and lake trout by the First Nations people in the Lesser Slave Lake communities, walleye, northern pike, perch, brook trout, Lake whitefish and arctic grayling by the residents in Swan Hills communities, and rainbow trout, arctic grayling, mountain whitefish, Northern pike and walleye by the residents in the communities nearby Hinton.

The results from the above surveys were derived from adults only. Fish consumption rates could vary in different subpopulations (USEPA 2000). Children may consume larger quantities compared to their body weight than adults. Prenatal exposure may occur through pregnant women. For the purpose of risk management, these subpopulations are considered as potential high risk groups for exposure to mercury from fish consumption.

3.3 Estimated Exposures

Exposure ratios were estimated for consuming walleye and northern pike. Estimated exposure ratios based on the estimated fish consumption divided by the pTDIs from Health Canada are summarized in Table 13 for women of reproductive age and Table 14 for adults. Specific fish consumption rates were not available for women of reproductive age and young children. As a result, the estimation of exposures for young children was not performed. The fish consumption rate for all adults was used for estimating exposures for women of reproductive age.

In general, the estimated exposure ratios were greater than one for the high intake group, especially for a subpopulation of women of reproductive age if consuming predatory fish like the larger walleye and Northern pike. The values of pTDIs were derived from risk assessment approaches with many assumptions and uncertainties. The risk assessment is specifically designed to avoid underestimating risk. The results do not mean that specific individuals or populations face inevitable or even likely health consequences from mercury exposure. An estimated exposure ratio greater than one should be used as a reference point for making risk management decisions. In particular, those exposure scenarios with an exposure ratio greater than one warrant closer attention including providing information about maximum recommended fish consumption to allow consumers to make safe eating choices.

Many factors influence the estimated exposure levels such as body weight and consumption rates. The body weight of 75 kg used in this assessment was derived from the 1994 National Population Health survey in Alberta adults. In this report, the age-specific body weights for women at reproductive age and young children in Alberta were not available. The average body weights used by Health Canada were 63 kg for women of reproductive age, 35.4 kg for five - 11 year old group, and 16.8 kg for one - four year old group. The consumption rates used in this report were based on the three surveys of adults living in Central Alberta. The estimated exposure was solely based on fish from local specific sources. People may also be exposed to mercury from market fish and other market food items.

Table 10. Estimated Exposure Ratios for Women of Reproductive Age[a]

Lake and Species	Local Consumer High Intake (1.0 kg/d)	Local Consumer Median Intake (0.5 kg/d)	Subsistence Consumer High Intake (2.0 kg/d)
[illegible]			
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Lake and Species	Local Consumer High Intake (170 g/d)	Local Consumer Medium Intake (50 g/d)	Subsistence Consumer High Intake (270 g/d)
North Wabasca Lake			
Northern pike	6.1	1.2	9.4
Walleye	3.5	1.0	5.6
Peerless Lake			
Lake trout	1.9	< 1	3.0
Pigeon Lake			
Lake whitefish	< 1	< 1	< 1
Walleye	1.9	< 1	3.0
Pine Lake			
Northern pike	2.9	< 1	4.6
Walleye	3.6	1.1	5.7
Pinehurst Lake			
Northern pike	11	3.1	17
Walleye	7.9	2.3	13
Pinto Lake			
Lake trout	9.0	2.9	16
Richardson Lake			
Northern pike*	3.7	1.1	5.9
Walleye*	3.0	< 1	4.8
Lake whitefish	1.0	< 1	1.5
Rock Island Lake			
Northern Pike	1.0	< 1	1.6
Walleye	1.5	< 1	2.3
Rolling Hills Reservoir			
Northern pike	14	4.0	22
Walleye	15	4.3	24
Skaddon Lake			
Northern pike	1.6	1.0	2.5
Walleye	2.1	1.0	3.3
Snake Lake			
Northern pike	0.7	< 1	1.0
Walleye	0.5	< 1	1.0
Sturgeon Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	1.9	< 1	3.1
Walleye	2.3	< 1	3.8
Sylvan Lake			
Lake whitefish	1.5	< 1	2.4
Walleye	2.7	< 1	4.4
Touchwood Lake			
Lake whitefish	1.4	< 1	2.3
Northern pike	11	3.3	169
Walleye	12	3.6	20
Wabamun Lake			
Lake whitefish	0.46	0.13	0.73
Northern pike	4.96	1.47	7.91
Whitefish Lake (2009/2010)*			
Lake whitefish	9.4	2.8	150
Northern pike	8.4	2.5	13
Walleye	11	3.3	18

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Lake and Species	Local Consumer High Intake (170 g/d)	Local Consumer Medium Intake (50 g/d)	Subsistence Consumer High Intake (270 g/d)
Whitefish Lake(2012/2013)[c]			
Lake whitefish	1.6	< 1	2.6
Northern pike	6.6	2.5	13.7
Walleye	10.1	3.0	16.1
Winyarm Lake			
Northern pike	1.6	1.0	2.5
Walleye	2.5	1.0	4.0
Wizard Lake			
Northern pike	2.6	< 1	4.1
Wolf Lake			
Lake whitefish	1.4	< 1	2.1
Northern pike	4.4	1.3	7.0
Walleye	7.7	2.3	12.3

Note: mean of total mercury listed in Tables 6, 7, 8, and 9; body weight = 65 kg; pTDI = 0.2 µg/kg bw/d for women
[a] Exposure ratios are rounded to 2 significant figures in keeping with the precision of the data they are based upon. [b] Sampling year for lake if lake was sampled in different years. [c] calculations based on data from Environment Canada

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Table 14 Estimated Exposure Ratios for Adults

Lake and Species	Local Consumer High Intake (170 g/d)	Local Consumer Medium Intake (50 g/d)	Subsistence Consumer High Intake (270 g/d)
Amisk Lake			
Northern pike	2.7	1.0	4.3
Walleye	4.4	1.3	7.0
Baptiste Lake (2011/2012)[a]			
Northern pike	< 1	< 1	1.1
Walleye	< 1	< 1	< 1
Baptiste Lake (2012/2013)[a]			
Lake whitefish	< 1	< 1	1.5
Northern pike	1.7	< 1	2.7
Walleye	2.6	< 1	4.1
Beaver Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	2.2	< 1	3.6
Walleye	1.8	< 1	2.8
Bitscho Lake			
Northern pike	<1	<1	0.6
Walleye	1.0	<1	0.9
Bourque Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	1.5	< 1	2.3
Walleye	1.8	< 1	2.8
Calling Lake			
Northern pike	< 1	< 1	1.3
Walleye	< 1	< 1	1.2
Chinchaga River			
Walleye	2.2	1.0	3.5
Chrystina Lake			
Brook trout	1.0	<1	1.6
Cowoki Reservoir			
Northern pike	2.9	<1	4.6
Walleye	2.3	<1	3.7
Crawling Valley Reservoir			
Northern pike	1.6	<1	3.0
Walleye	2.6	<1	4.2
Cross (Steele)Lake			
Northern pike	1.0	< 1	1.7
Dove Lake[a]			
Northern pike	< 1	< 1	1.3
Walleye	1.1	< 1	1.7
Eagle Lake			
Northern pike	< 1	< 1	< 1
Walleye	1.0	< 1	1.6
Edith Lake			
Brook trout	<1	<1	1.4
Elinor Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	3.5	1.0	5.5
Walleye	3.6	1.1	5.7

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Lake and Species	Local Consumer High Intake (170 g/d)	Local Consumer Medium Intake (50 g/d)	Subsistence Consumer High Intake (270 g/d)
Ethel Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	2.1	< 1	3.3
Walleye	2.2	< 1	3.6
Goodfish Lake			
Northern pike	2.3	< 1	3.6
Walleye	1.4	< 1	2.2
Gregoire Lake			
Lake whitefish	< 1	< 1	< 1
Walleye	< 1	< 1	1.5
Hay River			
Walleye	3.0	<1	4.8
Heart Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	< 1	< 1	1.2
Walleye	< 1	< 1	< 1
Hilda Lake			
Northern pike	2.5	< 1	3.9
Walleye	3.3	< 1	5.3
Hutch Lake			
Walleye	< 1	< 1	< 1
Isle Lake (2009/2010)[a]			
Northern pike	< 1	< 1	< 1
Walleye	1.0	< 1	1.6
Isle Lake (2010/2011)[a]			
Northern pike	1.9	1.0	3.0
Lake whitefish	< 1	<1	<1
Kehewin Lake			
Northern pike	1.9	<1	3.1
Walleye	1.4	<1	2.3
Keho Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	< 1	< 1	1.1
Walleye	1.1	< 1	1.7
Kinnaird Lake			
Northern pike	2.1	1.0	3.4
Walleye	3.3	1.0	5.3
Kirby Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	< 1	< 1	< 1
Lac Bellevue			
Walleye	1.7	1.0	2.8
Lac la Nonne			
Lake whitefish	< 1	< 1	< 1
Northern pike	1.5	< 1	2.5
Walleye	2.7	< 1	4.3
Yellow Perch	< 1	< 1	< 1
Lac Ste Anne			
Walleye	< 1	< 1	1.1

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Lake and Species	Local Consumer High Intake (170 g/d)	Local Consumer Medium Intake (50 g/d)	Subsistence Consumer High Intake (270 g/d)
Lake Athabasca			
Lake trout	1.3	< 1	2.1
Lake whitefish	< 1	< 1	< 1
Northern pike	1.0	< 1	1.7
Walleye	1.3	< 1	2.0
Lake Isle (2012/2013)[a]			
Northern Pike	< 1	< 1	< 1
Laurier Lake			
Northern pike	2.3	1.0	3.7
Len Thompson			
Rainbow Trout	1.0	< 1	1.1
Lesser Slave Lake East Basin			
Northern pike	2.0	1.0	3.2
Walleye	1.6	1.0	2.6
Lesser Slave Lake West Basin			
Northern pike	1.6	1.0	2.6
Walleye	1.7	1.0	2.8
Little Bow Reservoir			
Northern pike	2.3	< 1	3.7
Long Lake			
Northern pike	1.7	1.0	2.7
Walleye	2.1	1.0	3.4
Loon River			
Walleye	1.7	< 1	2.6
Marie Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	1.2	< 1	1.9
Walleye	< 1	< 1	1.5
McGregor Lake			
Northern pike	5.0	1.5	7.9
Walleye	3.1	< 1	4.9
McLeod Lake			
Rainbow Trout	< 1	< 1	< 1
McMillan Lake			
Northern pike	1.9	< 1	3.1
Meander River			
Northern pike	1.0	<1	1.5
Walleye	1.0	<1	1.3
Moonshine Lake			
Rainbow Trout	< 1	< 1	< 1
Moose Lake (2011/2012)[a]			
Northern pike	1.6	< 1	2.6
Walleye	2.4	< 1	3.9
Moose Lake (2012/2013)[a]			
Cisco	< 1	< 1	< 1
Lake whitefish	< 1	< 1	< 1
Northern pike	< 1	< 1	< 1
Walleye	< 1	< 1	1.4
Yellow Perch	< 1	< 1	< 1

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Lake and Species	Local Consumer High Intake (170 g/d)	Local Consumer Medium Intake (50 g/d)	Subsistence Consumer High Intake (270 g/d)
Nipisi Lake			
Northern pike	< 1	< 1	< 1
North Wabasca Lake			
Lake Whitefish	3.6	1.0	5.7
Northern pike	1.5	1.0	2.4
Walleye	1.3	< 1	2.1
Peerless Lake			
Lake trout	< 1	< 1	1.1
Pigeon Lake			
Lake whitefish	< 1	< 1	< 1
Walleye	< 1	< 1	1.1
Pine Lake			
Northern pike	1.1	< 1	1.8
Walleye	1.4	< 1	2.2
Pinehurst Lake			
Northern pike	4.0	1.2	6.4
Walleye	3.0	1.0	4.7
Pitchimi Lake			
Lake trout	3.7	1.1	5.9
Richardson Lake			
Northern pike[b]	1.4	< 1	2.2
Walleye[b]	1.1	< 1	1.8
Lake whitefish	< 1	< 1	1.0
Rock Island Lake			
Northern pike	1.0	< 1	1.6
Walleye	1.5	< 1	2.3
Rolling Hills Reservoir			
Northern pike	5.2	1.5	8.2
Walleye	5.6	1.6	8.9
Skeleton Lake			
Northern pike	1.0	< 1	1.0
Walleye	1.0	< 1	1.3
Snipe Lake			
Northern pike	< 1	< 1	< 1
Walleye	< 1	< 1	< 1
Sturgeon Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	< 1	< 1	1.2
Walleye	< 1	< 1	1.4
Sylvan Lake			
Lake whitefish	< 1	< 1	< 1
Walleye	1.0	< 1	1.7
Touchwood Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	4.3	1.2	6.8
Walleye	4.7	1.3	7.4
Wabamun Lake			
Lake whitefish	0.17	<1	0.28
Northern pike	1.89	1.0	3.0

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Lake and Species	Local Consumer High Intake (170 g/d)	Local Consumer Medium Intake (50 g/d)	Subsistence Consumer High Intake (270 g/d)
Whitefish Lake (2009/2010)[a]			
Lake whitefish	3.6	1.0	5.7
Northern pike	3.2	< 1	5.0
Walleye	4.3	1.3	6.8
Whitefish Lake(2012/2013)[a]			
Lake whitefish	< 1	< 1	< 1
Northern pike	3.3	< 1	5.2
Walleye	3.8	1.1	6.1
Winiqami Lake			
Northern pike	1.0	< 1	1.0
Walleye	1.0	< 1	1.5
Wizard Lake			
Northern pike	< 1	< 1	1.5
Wolf Lake			
Lake whitefish	< 1	< 1	< 1
Northern pike	1.7	< 1	2.7
Walleye	2.9	< 1	4.7

Note: mean of total mercury listed in Tables 6, 7, 8 and 9; body weight = 73 kg; pTDI = 0.47 µg/kg bw/d for adults.
[a] Sampling year for lake if lake was sampled in different years [b] calculations based on data from Environment Canada

3.4 Consumption Limits

For the purpose of quantitative fish advisories, the lifetime consumption limits were calculated for subgroups of women, young children and adults if total mercury levels in fish exceeded 0.2 µg/g (Table 15).

These consumption limits were specific to fish species and site. The values provide the information on the maximum amount of local fish that can be safely consumed on a weekly basis for a lifetime by the identified subpopulations for fish specified from the specified locations. Fish preparation and cooking methods do not reduce the concentrations of total mercury in fish (Morgan et al. 1997).

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Table 15 Lifetime Fish Consumption Limits[a]

Lake and Species	Hg µg/g	Women g/week	Children (6-11 yr) g/week	Children (1-4 yr) g/week	Adults g/week
Amisk Lake					
Northern pike	0.54	170	68	37	440
Walleye	0.89	100	42	23	270
Bashaw Lake					
Northern pike	0.36	240	97	53	633
Walleye	0.52	176	72	39	465
Beaver Lake					
Northern pike	0.45	201	82	44	530
Walleye	0.35	258	105	57	680
Bourgeau Lake					
Northern pike	0.30	305	124	67	804
Walleye	0.36	253	103	56	667
Chinchaga River					
Walleye	0.44	210	84	46	553
Cowichi Reservoir					
Northern pike	0.59	150	63	34	410
Walleye	0.47	180	79	41	490
Crowfoot Valley Reservoir					
Northern pike	0.36	240	97	53	630
Walleye	0.54	170	68	37	440
Cross (Steele) Lake					
Northern pike	0.21	430	174	95	1134
Dore Lake[2]					
Northern pike	0.34	260	109	59	707
Walleye	0.57	159	65	35	420
Eagle Lake					
Walleye	0.21	430	178	97	1157
Elinor Lake					
Northern pike	0.70	130	53	29	343
Walleye	0.73	125	51	28	329
Ethel Lake					
Northern pike	0.42	219	89	48	579
Walleye	0.45	201	82	44	531
Goodfish Lake					
Northern pike	0.46	198	81	44	524
Walleye	0.28	324	131	72	854
Hay River					
Walleye	0.61	150	61	33	400
Hilda Lake					
Northern pike	0.50	162	74	40	451
Walleye	0.67	136	55	30	358
Isle Lake[1]					
Northern pike	0.36	240	97	53	630
Kehewin Lake[1]					
Northern pike	0.39	230	95	52	620
Walleye	0.29	310	130	70	830
Kehiu Lake					
Walleye	0.22	410	168	91	1081

Lake and Species	Trig (g/g)	Woman (g/week)	Children (8-11 yr) (g/week)	Children (5-4 yr) (g/week)	Adults (g/week)
Kimball Lake					
Northern pike	0.44	210	84	48	393
Walleye	0.47	140	55	30	365
Lac Bellevue					
Walleye	0.35	285	109	59	690
Lac la Nonne					
Northern pike	0.31	252	118	65	778
Walleye	0.35	165	67	37	457
Lake Athabasca					
Lake trout	0.27	360	140	75	890
Northern pike	0.21	430	180	48	1,100
Walleye	0.20	350	140	78	820
Lauder Lake					
Walleye	0.47	160	75	43	510
Lesser Slave Lake East Basin					
Northern pike	0.33	290	110	61	730
Walleye	0.35	250	110	58	690
Lesser Slave Lake West Basin					
Northern pike	0.40	230	82	50	630
Walleye	0.33	280	110	61	730
Little Bow Reservoir					
Northern pike	0.47	160	75	43	510
Long Lake					
Northern pike	0.36	270	110	59	710
Walleye	0.43	215	88	47	555
Loon River					
Walleye	0.34	271	110	65	710
Marie Lake					
Northern pike	0.24	370	153	86	990
McGregor Lake					
Northern pike	1.06	81	37	20	240
Walleye	0.62	150	60	33	380
McMillan Lake					
Northern pike	0.39	233	85	52	616
Moose Lake					
Northern pike	0.38	243	85	54	660
Walleye	0.45	165	75	41	485
North Wabasca Lake					
Northern pike	0.31	290	120	65	770
Walleye	0.27	340	140	75	890
Pine Lake					
Northern pike	0.22	438	160	98	1077
Walleye	0.27	333	135	76	878
Pinehurst Lake					
Northern pike	0.81	110	48	25	330
Walleye	0.60	150	62	36	430
Pitchers Lake					
Lake trout	0.75	120	45	27	320
Richardson Lake[1]					
Northern pike	0.28	320	130	71	843
Walleye	0.23	385	160	87	1038
Walleye	1.1	81	33	18	210

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Lake and Species	Tring (ug/g)	Women (ug/g)	Children (5-11 yr) (ug/g)	Children (1-4 yr) (ug/g)	Adults (ug/g)
Tolley Hills Reservoir					
Northern pike	1.0	450	95	19	250
Walleye	1.1	51	33	19	210
Sylvan Lake					
Walleye	0.21	433	170	50	1142
Southwood Lake					
Northern pike	0.05	125	43	23	200
Walleye	0.06	67	33	21	200
Ewanchuk Lake					
Northern pike	0.10	233	67	33	433
Wheatlet Lake					
Lake whitefish	0.72	133	33	20	233
Northern pike	0.03	133	33	21	300
Walleye	0.07	133	40	23	233
Round Lake					
Northern pike	0.33	433	133	133	1333
Wolf Lake					
Northern pike	0.30	233	133	33	133
Walleye	0.08	133	33	33	833

Note: body weight = 75 kg for adults, 60 kg for women, 38 kg for children 5 – 11 yr, and 16 kg for children 1 – 4 yr, and = 0.2 µg/kg bw/d for women at reproductive age and young children, and 0.47 µg/kg bw/d for adults.
* Consumption limits are rounded to 2 significant figures in keeping with the precision of the data they are based upon. Numbers were rounded down to 0 in keeping with the precautionary basis for these limits.
† calculations based on data from Environment Canada

3.5 Fish Consumption Advisories

Fish consumers may be exposed to MeHg by consuming locally-caught fish. MeHg is rapidly absorbed after ingestion and distributed throughout the body (NRC 1980). MeHg in the body is relatively stable and can cross the placental and blood/brain barriers (Kenyon et al. 1992). The half-life of MeHg in the human body varies from 44 to 80 days (USEPA 2000). MeHg leaves the human body via urine, feces and breast milk. Small amounts of ingested MeHg are eliminated from the body with no overall adverse effects. At high exposure levels, MeHg produces a variety of health effects. Larger amounts of MeHg may damage the nervous system. Neurotoxicity may occur in the developing embryo or fetus during pregnancy and in young children. As a result, it is prudent to reduce MeHg exposure for women of reproductive age and young children. The pTDIs proposed by Health Canada are intended to protect susceptible populations.

Because mercury occurs naturally, mercury is found in all commercial or non-commercial fish and other foods at low levels. People are exposed to very low levels of mercury via sources such as breathing the air, mercury amalgam dental fillings and eating other foods. Alberta Health and Wellness conducted a survey of mercury levels in blood, urine and hair in adults and children living in the Wabamun Lake and surrounding area communities in 2006 (AHW 2006). The survey found that the

average levels of total mercury in blood, urine and hair in Alberta participants were lower than people living in other areas and countries.

Mehlig levels are high enough in some fish species in some rivers and lakes that limitation of fish consumption is warranted. Although fish consumers may be exposed to relatively higher levels of Mehlig it may eat large amounts of total mercury containing fish. The results from three surveys from Northern Alberta indicated that local fish consumption is not the primary source of dietary mercury intake for most surveyed populations.

In order to protect all human consumers, issuing a fish consumption advisory is one risk management option. Fish consumption advisories are designed to reduce potential health risks of consumption for local fish consumers. Advisories should provide the necessary information to the public, so that local fish consumers can voluntarily restrict their fish consumption to a level judged to be safe. Fish consumption advisories elicit voluntary actions unlike mandatory measures such as catch and release regulations or outright fishing bans which restrict consumer actions.

Since the early 1990s, some fish consumption advisories related to mercury have been issued and published in the Alberta Guide to Sportfishing Regulation annually. In Alberta, the provincial government is responsible for issuing and reviewing fish consumption advisories for non-commercial fish. The Ministries of Alberta Environment and Sustainable Resource Development and Alberta Health established the process to issue food consumption advisories in 1997. The advisories can take the form of non-consumption or restricted consumption advisories for adults and sensitive subpopulations.

3.3 Benefits of Fish Consumption

The benefits and risk of fish consumption is a recent focus of public health interest. Fish is an important source of nutrition for people, because it contains beneficial nutrients like the long-chain omega-3 fatty acids like eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), vitamin D, selenium and iodine. Fish is considered an excellent source of high quality protein. The benefits of fish consumption include the prevention of cardiovascular diseases, myocardial infarction (heart attack) and arrhythmia, especially reduction of risk for ischemic heart disease and stroke (Hang et al. 1999; Chan and Egeland 2004; Bouzans et al. 2005; Kong et al. 2005; Brie, Etherton et al. 2005; Stein 2005).

Health Canada reviewed the evidence showing an association between reduced risk of sudden cardiac death and fish consumption frequency at least once per week (Health Canada 2007). In one small case-control study, 79 cases, 158 controls, researchers found that a reduced risk of myocardial infarction with fish consumption of at least one meal per week was evident while noting that the beneficial polyunsaturated fatty acid levels from fish in human plasma also positively correlated with higher mercury exposure (Hallgren et al. 2001).

In contrast, a larger continuing Finnish population-based cohort study (1997 and 1998–1999) found, unexpectedly, that the higher maternal intake of fatty fish, specifically mackerel and herring, was associated with a lower risk of preterm birth, even after adjusting for confounding variables, including age, smoking, and parity (Hakola et al., 2015; Hakola et al., 2017). Mercury levels were found to be very comparatively low in both studies (0.09 mg/kg and 0.05 mg/kg, respectively). This finding suggests that the higher nutritional benefits of fatty fish may outweigh the potential risks associated with mercury exposure in this population, underscoring the importance of balancing nutritional benefits against contaminant risks when evaluating fish consumption during pregnancy.

Fish consumption is important for neurodevelopment in infant and young children (NAP) as an integral structural component of the brain and essential nutrient for pregnant women. DHA can be easily and rapidly absorbed into the developing brain during gestation and in the early years of life of young children (Innis, 2008). DHA has been found to improve the visual cortex development in healthy term infants (Uauy et al., 2003; Allen et al., 2006). Some studies showed that fish consumption can increase an child's intelligence quotient (Hibbeln et al., 2004; Cohen et al., 2004; Kuratani et al., 2008; Mikkelsen et al., 2008) and some indicated that increasing prenatal exposure to MeHg could decrease an child's intelligence quotient.

A cohort study found that maternal fish consumption was associated with visible neurodevelopment deficits in children (Hibbeln et al., 2004). In another study, researchers found that the benefits of moderate fish consumption in a percentage per week for women of reproductive age outweighed the potential risks from exposure to MeHg in fish (Mozaffarian and Rimm, 2006).

Although scientific evidence in the literature does not adequately demonstrate causation of all adverse health effects, evidence in general suggested that there are nutritional benefits from fish consumption. However, consuming large quantities of fish containing high MeHg levels should be avoided (Choi et al., 2009; Mozaffarian and Rimm, 2006; Kamrin, 2007; Mahaffey et al., 2008; Oken and Bellinger, 2008).

From a nutritional perspective, regular fish consumption is beneficial to the general population. From a toxicological perspective, fish is associated with a contaminant contaminants like methylmercury, which could a potential threat to humans. Fish consumption can be understandably confounded by the conflicting messages. Parents questioned if the difficulties more strongly by the danger messages (toxicological risk of mercury) rather than a beneficial nutritional messages (Kamrin et al., 2008). Following the release of some national fish consumption advisories in the U.S. in 2001, some pregnant women reduced their fish consumption (Oken et al., 2003).

Schoeman et al. (2008) performed a systematic review of 48 published studies on mercury exposures in women of reproductive age relating to incidence of adverse neurodevelopmental effects and found, based on analysis (Mahaffey et al., 2008; of the U.S. National Health and Nutrition Examination Survey (NHANES) measures of mercury in hair, that there were no findings of adverse effects for geometric mean mercury in maternal hair levels for mothers consuming fish once or two times a month.

with only, numbers reports of some adverse effects of geriatrics mass medicine in underwriter has issues for women considering that those in more life, so a month.

Communication to the public about they competitive Medicare benefits and rates in insurance is included in the corporation's advisory. Plan comparisons, advisories, discount models adapted to make a decision between Alpine Health's Gold and Silver plans and the corporation's model to calculate rates based on circumstances, assist in optimizing the combined benefits of the corporation with regard to accessible fitness and health technology development in Alpine and Energy Markets.

The establishment of guidelines for the corporation is an important part of public solutions. The advisory board recommended the corporation of a team that develops and tests CHP to accomplish the rate planning considered case [illegible]. The corporation has, Health Insurance Service advisory provides a complete Plan Guide. The study considers that [illegible] rate up to 12% [illegible]. Alternate rate rate is only relevant comparison recommendations, rates are 12% to 14% [illegible]. Planning considers indicates that rate is [illegible] rate up to 14% [illegible]. Many journey models indicates rate and that [illegible] rate is 12% [illegible]. The Guide results of study considers rate approach. Providing the choices to have made results of medicare is considered because from program and disadvantaging women.

Plan comparisons are based both coverage of rate, quality and flexibility. Flexibility is a rate which the corporation offers more than coverage of rate, quality or the medicare standard. Key rate performance of corporation medicare consider the rate of the corporation's medicare, assuming model that corporation standards offer plan. [illegible] Key rate performance, rate specific corporation models were calculated in three aspects. Unique model assessment is a flexibility company commercial that covers rate, recommendation comparison accounts of model that has different groups and considered in Alpine. As a model assessment, the company commercial that independently, Alpine chooses medicare rate additional insurance in model that accomplishes.

2.1 Underwrite Missing Plan Comparison Methodology

We recommended by the Alpine Health Management Committee. The underwrite missing plan comparison optimizes rate risk.

1. Determine health rate factors that [illegible] quality commercial flexibility problems. The advisory recommends "health consumerism" [illegible]
2. Determine health rate indicators [illegible] Alpine Health Consumer recommendations for consumerism consumerism. The advisory recommends consumerism model.
3. Determine health rate data that [illegible] quality, advisory, health [illegible] model.

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[1] Medicare Plan Comparison Guide, Alpine Health, 2026 edition, page 14. Rate comparisons are based on the assumed age 65 and a single coverage tier. Actual premiums vary by county and by plan year; consult the current Medicare Plan Finder before enrollment.

1. [illegible]
2. [illegible]

6 Conclusions

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible]

[illegible]

Table 16 Recommended Fish Consumption Limits

Water Body/Fish Species	Fish Sized over lbs	Consumption Limit (servings per week)			
		Women	Children (6-11 yr)	Children (1-4 yr)	Adults
Amisk Lake					
Northern pike	2	avoid	avoid	avoid	6
Walleye	1	avoid	avoid	avoid	4
Bapthite Lake					
Northern pike	4	3	1	0.5	no limit
Walleye	2	avoid	avoid	avoid	6
Beaver Lake					
Northern pike	5	3	1	0.5	no limit
Walleye	3	3	1	0.5	no limit
Bourque Lake					
Northern pike	3	4	2	1	no limit
Walleye	4	3	1	0.5	no limit
Chinchaga River					
Walleye	2	3	1	0.5	no limit
Cowdis Reservoir					
Northern pike	6	avoid	avoid	avoid	5
Crawling Valley Reservoir					
Northern pike	3	3	1.5	0.5	no limit
Walleye	2	avoid	avoid	avoid	6
Cross (Steele) Lake					
Northern pike	4	6	2.5	1.5	no limit
Dore Lake					
Northern pike	6	4	2	1	no limit
Walleye	2	avoid	avoid	avoid	5
Eagle Lake					
Walleye	3	6	2.5	1.5	no limit
Elinor Lake					
Northern pike	4	avoid	avoid	avoid	5
Walleye	4	avoid	avoid	avoid	4
Ethel Lake					
Northern pike	2	3	1	0.5	no limit
Walleye	2	3	1	0.5	no limit
Goodfish Lake					
Northern pike	3	3	1	0.5	no limit
Walleye	3	4	2	1	no limit
Hilda Lake					
Northern pike	2	2	1	0.5	6
Walleye	2	avoid	avoid	avoid	5
Isle Lake					
Walleye	3	6	2.5	1.5	no limit
Northern pike	7	3	1	0.5	no limit
Kathryn Lake					
Northern pike	6	3	1.5	0.5	no limit
Walleye	2	4	2	1	no limit
Kathy Lake					
Walleye	4	5	2	1	no limit
Kennard Lake					
Northern pike	3	3	1	0.5	no limit
Walleye	2	avoid	avoid	avoid	5

Water Body/Fish Species	Fish Sized over lbs	Consumption Limit (servings per week)			
		Women	Children (5-11 yr)	Children (1-4 yr)	Adults
Lac Bellevue					
Walleye	2	3	1	0.5	no limit
Lac la Nonne					
Northern pike	2	4	2	1	no limit
Walleye	2	avoid	avoid	avoid	6
Lake Athabasca					
Lake trout	6	5	2	1	no limit
Northern pike	6	5	2	1	no limit
Walleye	3	5	2	1	no limit
Lesser Slave Lake					
Northern pike	5	3	1	0.5	no limit
Walleye	3	4	2	1	no limit
Little Bow Reservoir					
Northern pike	3	2	1	0.5	6
Long Lake					
Northern pike	2	4	2	1	no limit
Loon River					
Walleye	2	4	2	1	no limit
Marie Lake					
Northern pike	4	5	2	1	no limit
McGregor Lake					
Walleye	4	avoid	avoid	avoid	5
McMillan Lake					
Northern pike	4	3	1	0.5	no limit
Moose Lake					
Northern pike	5	3	1	0.5	no limit
Walleye	4	2	1	0.5	no limit
North Wabasca Lake					
Northern pike	9	4	2	1	no limit
Walleye	4	4	2	1	no limit
Pine Lake					
Northern pike	3	5	2	1	no limit
Walleye	2	4	2	1	no limit
Pinehurst Lake					
Northern pike	3	avoid	avoid	avoid	4
Walleye	4	avoid	avoid	avoid	5
Pitchers Lake					
Lake trout	10	avoid	avoid	avoid	4
*Richardson Lake**					
Northern pike	9	4	2	1	no limit
Walleye	3	5	2	1	no limit
Rolling Hills Reservoir					
Northern pike	8	avoid	avoid	avoid	3
Walleye	6	avoid	avoid	avoid	3
Sylvan Lake					
Walleye	1	6	2.5	1.5	no limit
Touchwood Lake					
Northern pike	10	avoid	avoid	avoid	4
Walleye	5	avoid	avoid	avoid	5
Wabamun Lake					
Northern pike	7	3	1	0.5	no limit

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Water Body/Fish Species	**Fish** Sized over lbs	**Consumption Limit (servings per week)**			
		Women	**Children (5-11 yr)**	**Children (1-4 yr)**	**Adults**
Whitefish Lake					
Lake whitefish	8	avoid	avoid	avoid	5
Northern pike	4	avoid	avoid	avoid	5
Walleye	4	avoid	avoid	avoid	4
Wizard Lake					
Northern pike	2	6	2.5	1.5	no limit
Wolf Lake					
Northern pike	3	4	2	1	no limit
Walleye	2	avoid	avoid	avoid	5

*1 lb = 454 grams. **1 serving = 75 grams, ½ cup, 2.5 ounces, or a piece of cooked fish that fits into the palm of your hand. *** "Women" refers women at reproductive age (15-49 yr) and pregnant women. Adult* includes adults and child over 12 yr. * calculations based on data from Environment Canada

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Appendix A

Data from Environment Canada

9.1 Field Collection

Fish samples were collected by Environment Canada. Any fish were transported by a local fisherman to Alexandria on January and dropped whole and frozen to Saskatoon where they were processed. Processing included determination of fish total length, round weight, gas and total weight and gonad weight. Aging structures were removed with sterile pliers for later hour, dorsal and ventral, and stored for northern pike.

9.2 Laboratory Analysis

Fish samples were analysed at the Environment Canada laboratory for metal concentration by employing the cold vapor atomization spectrometry procedure (CVAAS) using a Milestone Direct Mercury Analyzer following USEPA method 7471 (USEPA 2007). A subsample of ca. 0.1 0.2 g of frozen homogenized dorsal fish was used for each analysis. Results are expressed on a wet weight basis. For each series of ca. ten fish, certified reference materials and blanks were run at the beginning and at the end of each batch of 10 samples. One sample was run in triplicate during each series run. No protocols run the 2012 fish. Fish tissue relative standard deviation of the triplicate was 6.1% (n=18) with average results with other runs. Certified reference materials and passing recoveries mean percent of certified values n = 1 standard deviations were 96.6 ± 2.0% (n = 6) n = 1 Fish from the National Institute of Standards and Technology (Standard Reference Materials Program - Gaithersburg - USA) and 94.8 ± 2.1 (n = 6) n = 1 Fish and 104 ± 1.0 (n = 6) n = 1 Fish from National Research Council Canada (Certified Reference Materials program - Ottawa). The method detection limit determined as 10 fold standard deviation of the blanks, was 0.11 ng Hg (approximately 2 ng/g dwt).

[illegible]

Unweighted Sample Sizes and Weighted Cohort Sizes for Cohort Characteristics

Cohort Characteristic	Unweighted Sample Size	Weighted Cohort Size, n (%)	Weighted Sample Size, n[a]
Overall			
Total cohort	[illegible]	[illegible]	[illegible]
Age, y, [illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Age, y, [illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Note: [illegible] [a]Weighted sample size [illegible]

Cohort Characteristics by Cohort Type for Cohort Characteristics Using Weighted Samples

Cohort Characteristic	[illegible]	[illegible]	[illegible]
Overall			
Total cohort	[illegible]	[illegible]	[illegible]
Age, y, [illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Age, y, [illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Note: [illegible]

Appendix B

Guide for Use of Food Consumption Advisory Information

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1. **Where to find food consumption advisory information?**

   Fish consumption advisories

   http://www.alberta.com/FishingSafetyProcedures/FishConsumptionAdvisory.aspx

   Wild game meat consumption advisories

   http://www.albertaregulations.ca/huntingmgt/gamemanage.html

2. **What are criteria for issuing food consumption advisories?**

   The criteria for issuing fish consumption advisories are

   1. If mercury levels are higher than 0.5 mg/kg (commercial fishing guideline), the advisory would be "avoid consuming fish",
   2. If mercury levels are between 0.2 - 0.5 mg/kg (Health Canada recommendation for subsistence consumers), the advisory would provide "consumption limits",
   3. If mercury levels are less than 0.2 mg/kg, advisory would not be issued,
   4. If the fish sample size is less than 5 per location, advisory would not be issued, and
   5. If the lakes are used for commercial fishing, advisories would not be issued until consulting with Canadian Food Inspection agency.

   The criteria for issuing wild game meat consumption advisories are based on the guidelines proposed by national or international regulatory agencies such as Health Canada and World Health Organization.

3. **How to find fish species and size?**

   The fish species are indicated under the "Species" in the table. Meanwhile, please check fish weight under the "Fish Size" in the table. If fish weighs less than the weight indicated in the table, there is no advisory against eating this size of fish.

4. **How to find meal size and frequency?**

   Please go to the "Consumption Limits", the meal size and frequency indicated as "servings per week". Check specific information on meal size and frequency for women, young children groups and adults.

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